CI/SfB (57)
Uniclass L7535
December 2003

NATURAL VENTILATION
FOR COMMERCIAL BUILDINGS

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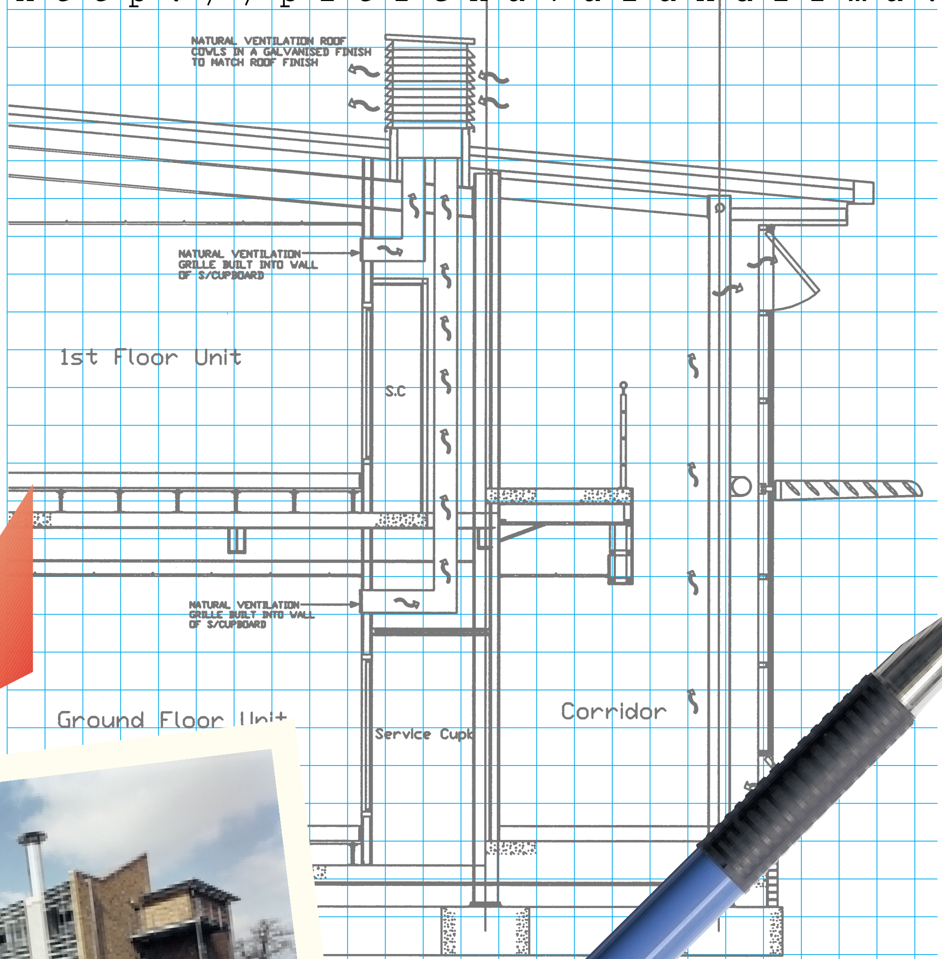

BRE's Environmental Building

SUSTAINABLE DESIGN SOLUTIONS

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NATURAL VENTILATION

The low-energy strategy

Low-energy natural ventilation is an increasingly important design strategy for commercial and other non-domestic buildings.

In comparison with air conditioning or mechanical ventilation it can bring:

- Economic benefits through savings in both capital equipment and running costs.
- Environmental benefits in reducing energy use and cutting greenhouse gas emissions.
- User benefits in providing controlled, comfortable conditions.

Intelligent solutions

Current technology and design software combined with sophisticated control systems mean that natural ventilation can provide optimum performance as well as the benefits indicated above.

Using the latest techniques, intelligent natural ventilation solutions can be applied to many buildings that would otherwise have defaulted to air conditioning.

Early consultation

The key to the successful implementation of a natural ventilation strategy is to consider its application during the preliminary stages in the design of a building (preferably at outline proposal stage). Decisions about building plan, orientation and other factors will enable the most effective use to be made of natural ventilation.

Clients, developers and building designers should therefore consult natural ventilation experts such as Passivent as early as possible in the design process.

PASSIVENT

Passivent services

Designing natural ventilation systems to be as efficient as possible requires specialised expertise.

With its in-house research and design team, Passivent can provide a comprehensive design and advisory service tailored to specific projects, covering both system design and product selection from a range of complementary ventilation strategies.

Passivent expertise

Since 1983 Passivent has been at the forefront in developing energy-efficient natural ventilation solutions for many kinds of building including student accommodation, nursing homes, flats, offices and schools.

As a leading partner in some of the most important research projects in the natural ventilation field, Passivent has also developed a range of products for the natural ventilation of non-domestic buildings.

Passivent design software

With so many variables in natural ventilation design it is important to understand how the elements interact with each other within the context of the building.

A key part of the NatVent™ research project (see overleaf) has been the production of software to assess the various forms of natural ventilation in different types of building.

Following on from this Passivent has developed its own advanced software (based on CIBSE AM10) to provide an integrated design approach that takes account of all facets of the ventilation requirement. This software is used to calculate sizes of air inlets and outlets to achieve optimum performance.

Passivent products

Passivent has developed a range of products (including acoustically treated options) which can be incorporated into natural ventilation systems for commercial buildings. More information on these is available on request.

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THE BACKGROUND

The NatVent™ project

NatVent™ is an EC/EU-funded project involving nine partners in seven countries, co-ordinated by the UK Building Research Establishment. Passivent, as one of the NatVent™ partners, has taken a leading role in developing practical solutions for the commercial building sector.

The NatVent™ group has carried out an in-depth study of natural ventilation and found that it is an effective design strategy for office buildings in the UK and other European countries with a moderate climate.

NatVent™ is now developing 'smart' solutions to promote the adoption of natural ventilation across Europe.

Benefits

The many benefits of naturally ventilated buildings identified by the NatVent™ project include:

Cost efficiency

- Naturally ventilated buildings typically consume less than half the energy used in air-conditioned buildings.
- Initial capital costs are also lower, typically by 15%.
- Operating costs can be 40% less in terms of energy consumption.
- Due to simplicity and durability of the components, costs are spread over a longer lifetime.
- Maintenance costs are significantly lower.
- Less space is required for plant rooms and services distribution.

Productivity gains

- 90% of building occupants prefer naturally ventilated buildings.
- Fewer incidents of sick building syndrome are reported.
- Occupants are provided with control over their immediate environment.

Environmental gains

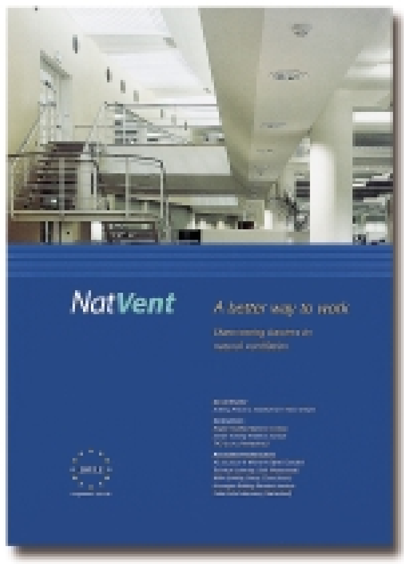
- Significant reduction in emissions of the greenhouse gas carbon dioxide (CO_2).
- Avoids using ozone-depleting substances as refrigerants.

CO_2 reduction

50% of CO_2 emissions in the UK derive from energy consumption in buildings. All buildings, both new and refurbished, must use energy more efficiently to reduce environmental damage.

Building Regulations Approved Document L Conservation of fuel and power includes a new performance standard for CO_2 emissions, the Carbon Performance Index, which will apply to buildings that are air-conditioned or mechanically ventilated. Index calculations will not be required for naturally-ventilated buildings.

System design



Good design is based on the principle that adequate ventilation is essential for the health, safety and comfort of building occupants, but that excessive ventilation leads to energy waste and discomfort. Building tightness, good ventilation for occupants and natural ventilation design should be considered together for a successful energy-efficient natural ventilation scheme.

Strategies have to be developed for winter and summer. Winter ventilation to maintain good indoor air quality must be balanced against minimising heat losses. Summer ventilation must offset excessive daytime heat gains and provide fresh air distribution.

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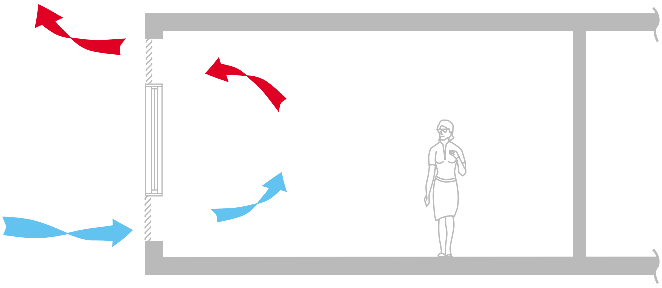
NATURAL VENTILATION STRATEGIES

BACKGROUND VENTILATION

Background ventilation is necessary to provide adequate indoor air quality throughout the year. This can be achieved by various types of façade mounted controllable ventilators usually providing 400mm²/m² of floor area or 3 l/s per occupant.

RAPID VENTILATION

Rapid ventilation is necessary to remove excess temperature from the space and is of prime importance during the summer. This is achieved by a variety of means, of which the principle natural ventilation strategies are detailed below;

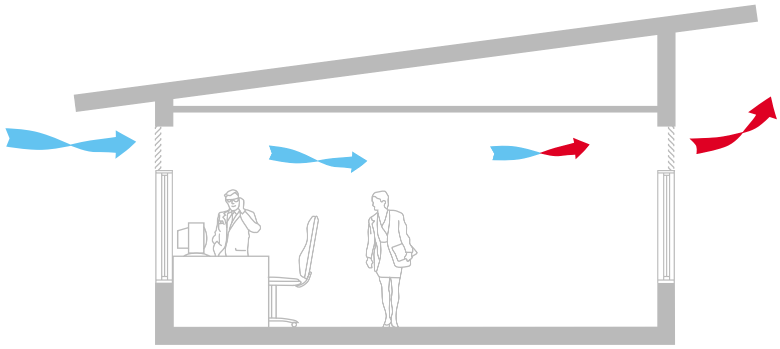


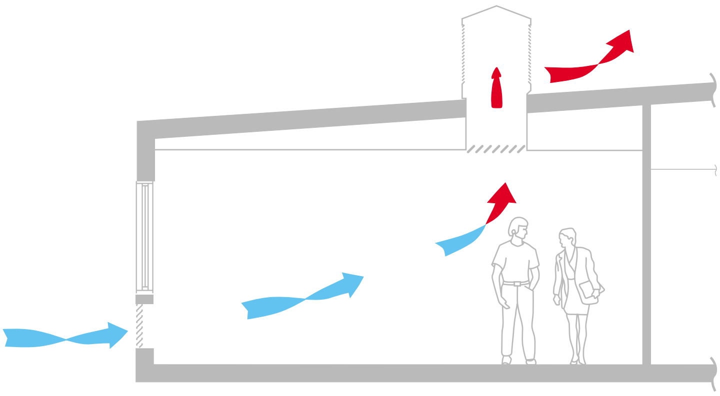
Single-sided ventilation

Single-sided ventilation, usually through large façade opening devices, is mainly driven by wind turbulence. Relatively low ventilation rates are achieved except with penetration depths of less than 2½ times the floor-to-ceiling height. Penetration depths are based on typical office occupant densities and are not applicable to higher occupant densities such as teaching spaces and seminar rooms.

Cross ventilation

Cross ventilation achieves good air change rates driven by pressure differences across the building. This method uses controllable high-capacity inlets/outlets on the building façades, and can achieve penetration depths of up to 5 times the floor-to-ceiling height, based on low occupant densities.





Passive stack ventilation

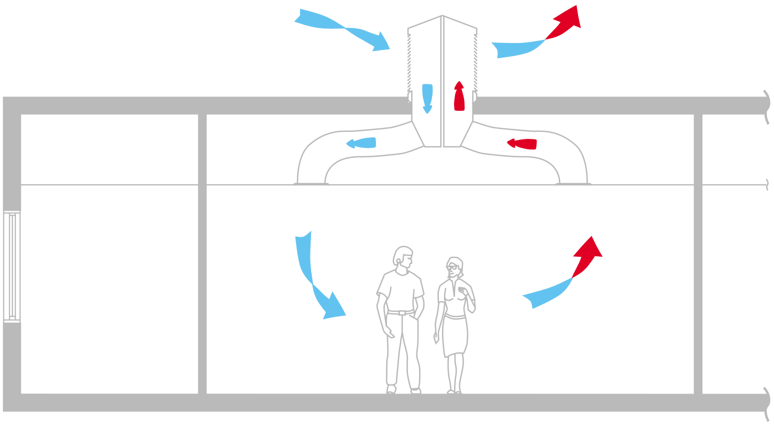
Passive stack ventilation (PSV) is the most effective natural ventilation strategy as it uses a combination of cross ventilation, buoyancy and the suction effect as the wind passes the terminal.

It can ventilate to twice the depth of cross ventilation as the outlet can be in the centre of a building.

It can be an effective night cooling strategy as internal and external temperature differences at night are typically high, so increasing convection.

PSV stacks can range from large central atria to local stacks feeding to roof-mounted terminals.

NATURAL VENTILATION STRATEGIES



Displacement ventilation

Displacement ventilation uses roof-mounted terminals with separated chambers to channel air down into the building regardless of wind direction. The cooler, denser air displaces warmer, lighter air upwards, which is drawn out through the leeward chambers of the terminals. This method can be used as part of a night cooling strategy.

Night cooling

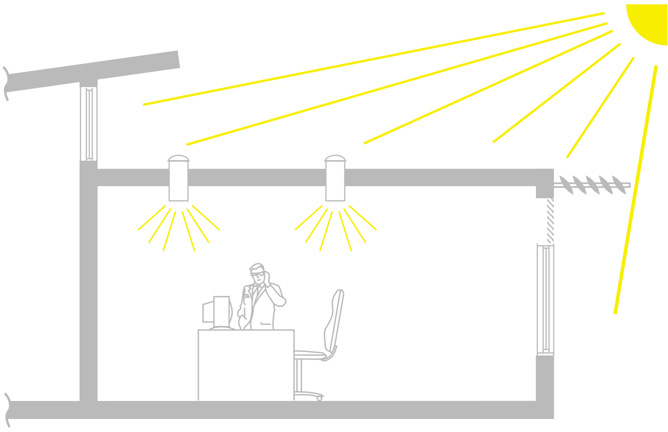
Night cooling uses the lower external temperatures at night to reduce the temperature of the building fabric, by means of automatic ventilation devices. The cooled thermal mass of the building is used the next day to reduce internal temperatures. A night cooling strategy in a suitable building design can reduce peak internal temperatures by 2 - 3ºC the following day. Natural night cooling by lowering the ambient temperatures can delay the use of energy consuming cooling equipment.

Mixed-mode ventilation

Natural ventilation alone is not suitable for some rooms due to their depth, internal heat loads or other factors. In these cases some mechanical assistance can be incorporated such as boost fans in outlets. If necessary local comfort cooling devices, such as split air conditioning or chilled ceilings, can be used effectively in co-operation with natural ventilation.

SOLAR CONTROL/DAYLIGHTING

Solar radiation through windows can be a major contributor to heat gain, and must be minimised for a natural ventilation strategy to be effective. External solar shading is very effective in reducing heat gain in summer while still allowing good daylighting and a useful solar contribution in winter. Correct design to balance these factors is essential. Tubular roof lights offer an excellent solution for balancing daylighting and solar heat gains.



SYSTEM CONTROL

An efficient and effective natural ventilation system should move air through the building in a carefully designed manner. The sizing and positioning of inlets, stacks and outlets are critical in achieving the correct ventilation performance.

Control of systems is also important to ensure maximum effectiveness and provide the correct level of ventilation at minimum energy cost.

Control components are available from Passivent that vary from simple occupant controlled devices to intuitive systems triggered by sensors which detect occupancy, temperature, humidity or air quality and CO_2, matching ventilation to demand. These can be integrated with an overall building management system.

SUSTAINABLE BUILDING DESIGN

Sustainability can be best defined as "improving the quality of life for all without damaging the environment or the ability of future generations to meet their own needs" Vision 21.

Sustainable buildings will encompass all facets of design but include natural ventilation, optimum use of daylighting, high thermal mass, solar shading, improved levels of insulation, use of renewable/ recyclable materials and effective lighting controls.

It is important that all members of the design team sign up to the achievement of a common project environmental policy, which acknowledges a commitment to maximise the environmental potential within reasonable constraints. Guidance documents such as BREEAM and SEAM (for schools) can lead a project to produce a successful and sustainable "green building".

The generic project illustrated opposite demonstrates many of the ventilation and daylight considerations required to achieve a sustainable building.

Ground and First Floor Ventilation *(illustrations 1 and 2 opposite)*

The inlet path for natural ventilation is via openable high-level façade devices and windows. The high level openings allow fresh air to pass into the ceiling void and then drop into the space below. This strategy provides cooling of the structure at night during summer months as well as tempering incoming air the next day. In winter this eliminates sources of draughts by opening windows, as the fresh air passing through the ceiling is prewarmed. A degree of external acoustic attenuation is also provided via the ceiling void. The openable windows are used to boost the ventilation rate, whilst providing additional user control of their own environment.

The façade and ceiling outlet louvres are insulated, so closure at night and during the morning warm-up period reduces heat loss, whilst the building is unoccupied. These motorised louvres are controlled automatically with manual override facility, to allow user interface.

The higher heat gain space is located on the lower floor of the North façade as this experiences the lowest solar gains. A boost fan has been incorporated in this case, providing a mixed mode strategy, for additional air movement during warmer weather. The roof-mounted terminals provide large fixed openings with Class-A rain rejection performance and an AA fire rating.

Daylighting and Corridor Ventilation *(illustration 3 opposite)*

External southerly solar shading reduces the external solar gains in summer, whilst the building orientation maximises heat gain and avoids glare during winter. Tubular rooflights allow natural daylight to enter the rear of the rooms. The reduced window area on the South façade, together with solar control glazing, reduces external heat gains. Daylight control is used with efficient artificial lighting to reduce energy usage.

Ventilation of the corridor is achieved using insulated openable façade devices at either end. The air is exausted via high level openings in the glazed façade. These motorised louvres are controlled automatically.

SUSTAINABLE BUILDING DESIGN

Illustration 1
Ground Floor Ventilation

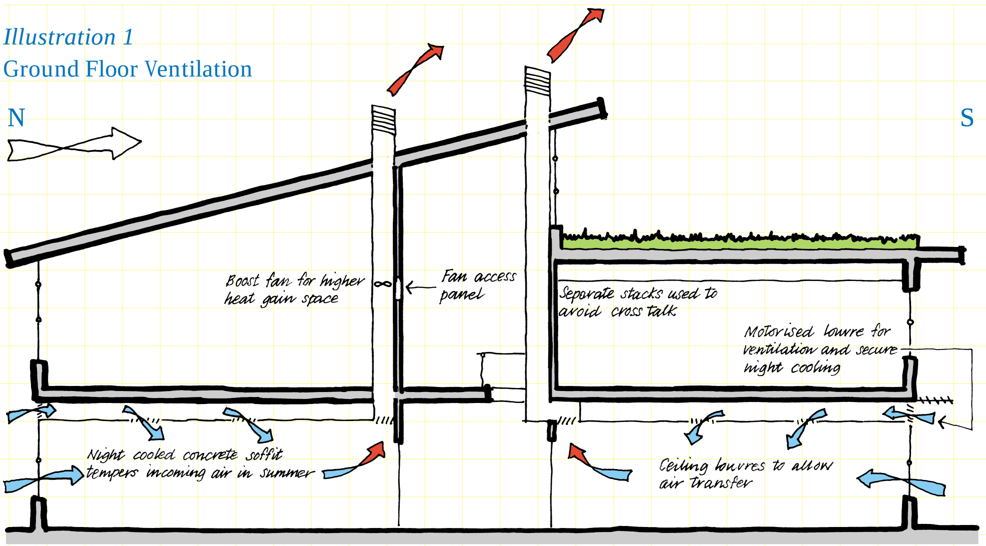


Illustration 2
First Floor Ventilation

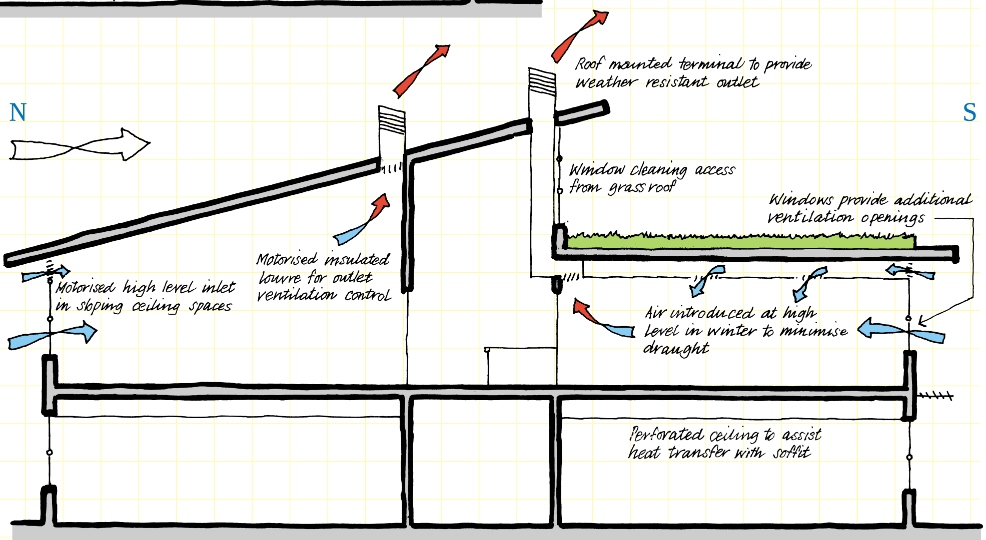
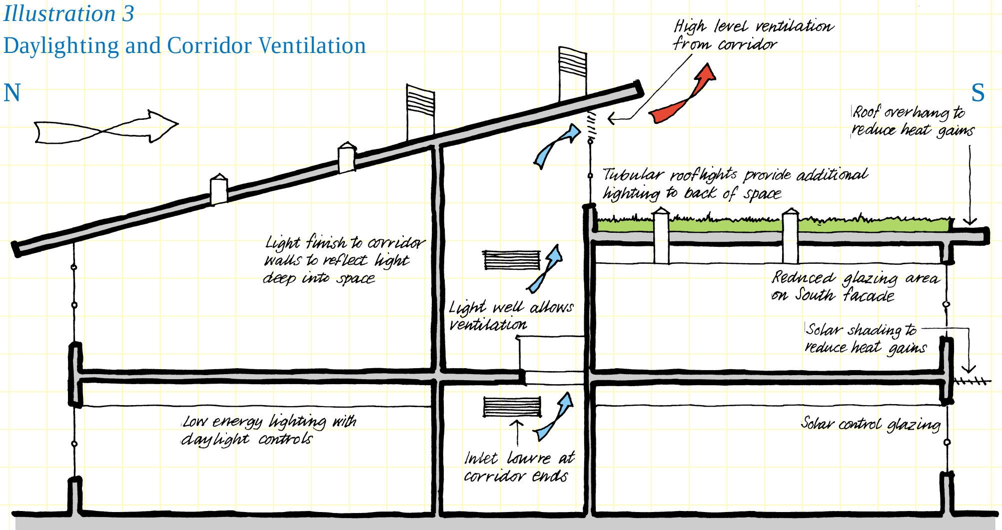


Illustration 3
Daylighting and Corridor Ventilation



Illustrations based on a design produced by Stride Treglown Davies

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FURTHER INFORMATION

Passivent products

Passivent product ranges include:

Passivent high-capacity roof terminals for PSV systems.

Passivent Aircool wall ventilators for air inlet/outlet in PSV and cross ventilation systems; installed in masonry, curtain walling or windows.

Passivent Tricklevent window-mounted units for background ventilation.

Passivent Airscoop roof-mounted units for displacement ventilation (direct or ducted).

Kingfisher solar shading louvres.

Separate literature is available for these products on request.

Quality assurance

Passivent products are designed and manufactured under an independently monitored quality assurance scheme to BS EN ISO 9001.

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